You should now be able to:

- understand the pH scale and the use of universal indicator and simple indicators like litmus
- know how the reactions of metals with acids are related to the position of the metal in the reactivity series
- describe and write equations (full and ionic) for the reactions between common metals and dilute sulfuric or hydrochloric acid
- understand that simple metal oxides are bases, and know that they react with acids to form a salt and water
- describe and write equations (full and ionic) for the reaction of copper(II) oxide with dilute sulfuric acid
- know that soluble metal hydroxides are alkaline, that they contain OH^- ions in solution, and that they react with acids to form a salt and water
- write equations (full and ionic) for the reactions between common metal hydroxides and acids
- know that carbonates react with acids to give a salt, carbon dioxide and water, and be able to describe and write equations (full and ionic) for common examples
- understand what is meant by an acid and a base according to the Arrhenius theory and the Bronsted–Lowry theory
- explain why hydrogen chloride gas dissolved in methylbenzene doesn't show simple acidic properties, whereas a solution in water does.

Questions

a) Which of the following will react with dilute sulfuric acid? Copper, copper(II) oxide, copper(II) hydroxide, copper(II) carbonate.

b) In the case of each of the substances which does react, write the full equation (including state symbols) for the reaction. All of these substances are insoluble solids.

a) Draw a labelled diagram of the apparatus you would use to collect a few test tubes of hydrogen gas from the reaction between magnesium and dilute hydrochloric acid. Write the full equation for the reaction.

b) Describe how you would test for the hydrogen.

c) Name a metal that won't react with dilute hydrochloric acid.

d) Name a metal which it would be dangerous to add to dilute hydrochloric acid.

e) In the Hindenburg airship disaster (see page 73), most of the people who died did so because they jumped out of the airship. Those who didn't jump tended to survive the fire. This is because when the hydrogen caught fire, the flame rose very quickly instead of engulfing the passenger section of the airship.

(i) What is formed when hydrogen burns? Write the equation for the reaction.

(ii) Why do you think that, when hydrogen burns, the flame rises quickly?

3 Read this description of the chemistry of metal A and some of its compounds, and then answer the questions.

Metal A has no reaction with dilute hydrochloric acid or dilute sulfuric acid. It forms a black oxide, B, which reacts with hot dilute sulfuric acid to give a blue solution, C. Metal A also forms a green compound, D, which reacts with dilute nitric acid to give a colourless gas, E, and another blue solution, F. The colourless gas, E, turned lime water milky.

a) Name A, B, C, D, E and F.

b) Write the full equations for the reactions between

(i) B and dilute sulfuric acid

(ii) D and dilute nitric acid.

4 *a)* Nickel, Ni, is a silvery metal just above hydrogen in the reactivity series. Nickel(II) compounds in solution are green. Describe what you would see if you warmed some nickel with dilute sulfuric acid in a test tube. Include a description of how you would test for any gas given off.

b) Write the full equation for the reaction between nickel and dilute sulfuric acid.

c) Nickel(II) carbonate is a green, insoluble powder. Describe what you would see if you added a spatula measure of nickel(II) carbonate to some dilute hydrochloric acid in a test tube. Include a description of how you would test for any gas given off.

d) Write **(i)** a full equation and **(ii)** the ionic equation for the reaction between nickel(II) carbonate and dilute hydrochloric acid.

5 Which of the following equations represent reactions between acids and bases? For each of the equations that is an acid-base reaction, state which substance is the acid and which the base.

a) $MgO(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2O(l)$

b) $CO_3^{2-}(s) + 2H^+(aq) \rightarrow CO_2(g) + H_2O(l)$

c) $2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2(g)$

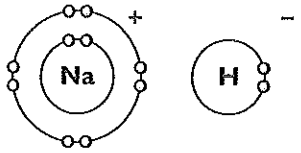
d) $H_2O(l) + HCl(g) \rightarrow H_3O^+(aq) + Cl^-(g)$

e) $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

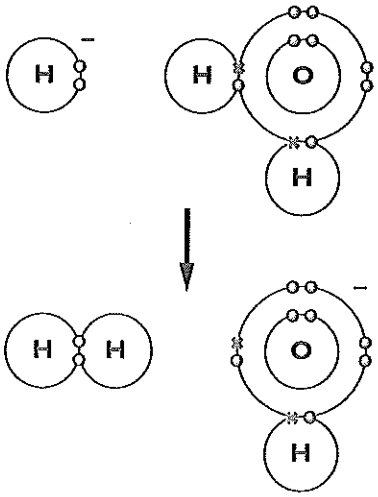
f) $NH_3(g) + HCl(g) \rightarrow NH_4^+(s) + Cl^-(s)$

g) $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

6 Sodium hydride, NaH, is a white ionic solid in which the hydrogen exists as an H^- ion. The electronic structures of the two ions are:



Sodium hydride reacts violently with water. The hydride ion reacts with the water like this:



a) At the beginning of the reaction there were sodium ions, hydride ions and water molecules present.

(i) Which of these acts as an acid? Explain your reasoning.

(ii) Which of these acts as a base? Explain your reasoning.

b) Name the products of this reaction.

c) Describe what you might expect to see during the course of the reaction.

d) Assuming that you used a reasonable quantity of sodium hydride, what would you expect the pH of the final solution to be?

7 Zinc granules react slowly with cold dilute sulfuric acid to give hydrogen gas and a colourless solution of zinc sulfate.

$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

Small amounts of copper(II) sulfate solution are often added to the mixture to increase the rate of the reaction. The copper(II) sulfate reacts with some of the zinc to produce copper. The copper in contact with the zinc speeds up the reaction.

Design an experiment to find out whether the rate of the reaction depends on how much copper(II) sulfate you add.

Remember – if you do an experiment like this, it is important to change only one thing at a time. As you want to find out what happens if you change the amount of copper(II) sulfate, it is important that everything else stays the same from one part of the experiment to the next.

Your account should include a diagram of the apparatus you are going to use, and an outline of how you will do the experiment. Full practical details are not expected – to describe this in detail could take you several hours of work!

You may find it useful to look back at Chapter 6 on rates of reaction for ideas.